U. S. DEPARTMENT OF AGRICULTURE

FARMERS' BULLETIN No. 1426

FARM PLUMBING

PLUMBING to-day is largely the assembling and installing of manufactured products. It requires less of the skill of the old-time lead worker and more of practical knowledge regarding house water supply and house drainage. The modern plumber must know something of hydraulics, mechanics, pneumatics, and sanitation. He must know what materials, pipes, and fixtures are most appropriate, how they may best be installed and what they cost. Five to ten per cent of the cost of a house, if fully equipped, goes into the plumbing—an expense justifying full study and information.

This bulletin is for the farmer-plumber and those desiring to follow the work where a regular plumber is employed. All the conveniences hoped for need not be put in at one time, but the work should always be planned in advance so as to combine the best arrangement at the lowest cost. A sink will naturally come first, but the plumbing should be extended to include at least a bathroom. A small spare room or closet can often be converted into a bathroom and so contribute very greatly to the convenience, comfort, and health of the whole family.

Washington, D. C.

October, 1924
Revised October, 1930

FARM PLUMBING

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CONTENTS

INTRODUCTION

FEW THINGS CONTRIBUTE MORE to our convenience and comfort than good plumbing. How much they contribute to health and longer life, none can say, but it is certainly large.

America has better plumbing than any other nation in the world, but it is unfortunate that its extension to the country has lagged far behind its use in the city. The 1920 census reports 643,899 of the 6,448,343 farms in the United States as having water piped into the house. This is only 1 farm out of 10, and means that 5,804,444 farms, or 9 out of 10, have little or no plumbing. To aid in bringing simple and good plumbing into these homes and in improving existing installations is the purpose of this bulletin.[1]

The present-day tendency is toward simple, direct, standardized plumbing to combine the greatest usefulness with the least cost. This bulletin describes and illustrates the important things entering into simple, sound practice and in sufficient detail to enable those handy with tools to do their own work. It is impossible to avoid minor disagreements with some of the thousands of local plumbing ordinances, but in general the recommendations conform to well-established sanitary practice and may be accepted in most communities as leading to safe, dependable, and inexpensive plumbing.

HOME WORK

Every farmer can not do his own plumbing. A layout that looks simple on paper may be difficult to install, and in inexperienced hands often results in dissatisfaction. Many have the skill and tools to do creditable work, and may profitably utilize the service of

[1] Farmers' Bulletins, 1448, Farmstead Water Supply, and 1227, Sewage and Sewerage of Farm Homes, may profitably be read in connection with this bulletin.

plumbing-supply and mail-order houses. This service may include plan, bill of materials, and estimate of cost prepared from the farmers' dimensioned sketch. This enables the supply house to ship the correct piping and fixtures and the householder to install them without great difficulty and labor. Wrecking companies often carry salvaged stocks which can be bought cheaply; but cheap plumbing is likely to prove dear in the long run, and used plumbing, like any secondhand goods, should be examined very closely. Local and State plumbing regulations are law. Where such exist, the farmer should study them and make his installation conform to them. The services of a good, reliable plumber are recommended as being most likely to secure a lawful, dependable, and durable job. Figure 1 shows a very poor installation. Figure 2 shows an unsightly installation but one that is serviceable in mild climates. Figure 3 shows two crude homemade sinks, and Figure 4 shows a conveniently arranged kitchen with a 1-piece sink.

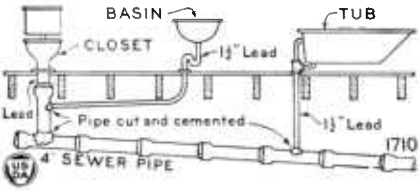

FIG. 1.—Plumbing fixtures poorly connected; the bathtub has no trap; the basin trap is subject to self-siphonage and is forced by bubbles of sewer air when the water-closet is flushed; cutting into vitrified sewer pipe makes rough, leaky, easily obstructed joints and is a poor substitute for branch fittings

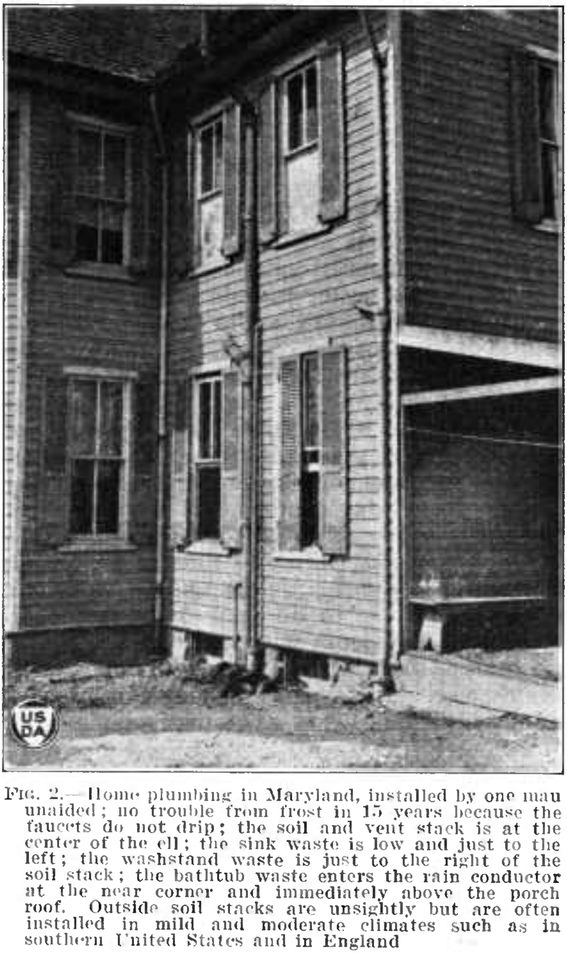

FIG. 2.—Home plumbing in Maryland, installed by one man unaided; no trouble from frost in 15 years because the faucets do not drip; the soil and vent stack is at the center of the ell; the sink waste is low and just to the left; the washstand waste is just to the right of the soil stack; the bathtub waste enters the rain conductor at the near corner and immediately above the porch roof. Outside soil stacks are unsightly but are often installed in mild and moderate climates such as in southern United States and in England

DEFINITIONS OF PLUMBING TERMS

The man who undertakes to do his own plumbing will find that the first essential is an understanding of the terms commonly used in the plumbing trade. Without such knowledge the intelligent consultation of catalogues and the

purchasing of the necessary fixtures and materials will be difficult. The terms defined below are the ones most frequently used.

Plumbing is the piping, with attachments, which conveys water into buildings and premises and carries out the sewage. Rain-water pipes are not included.

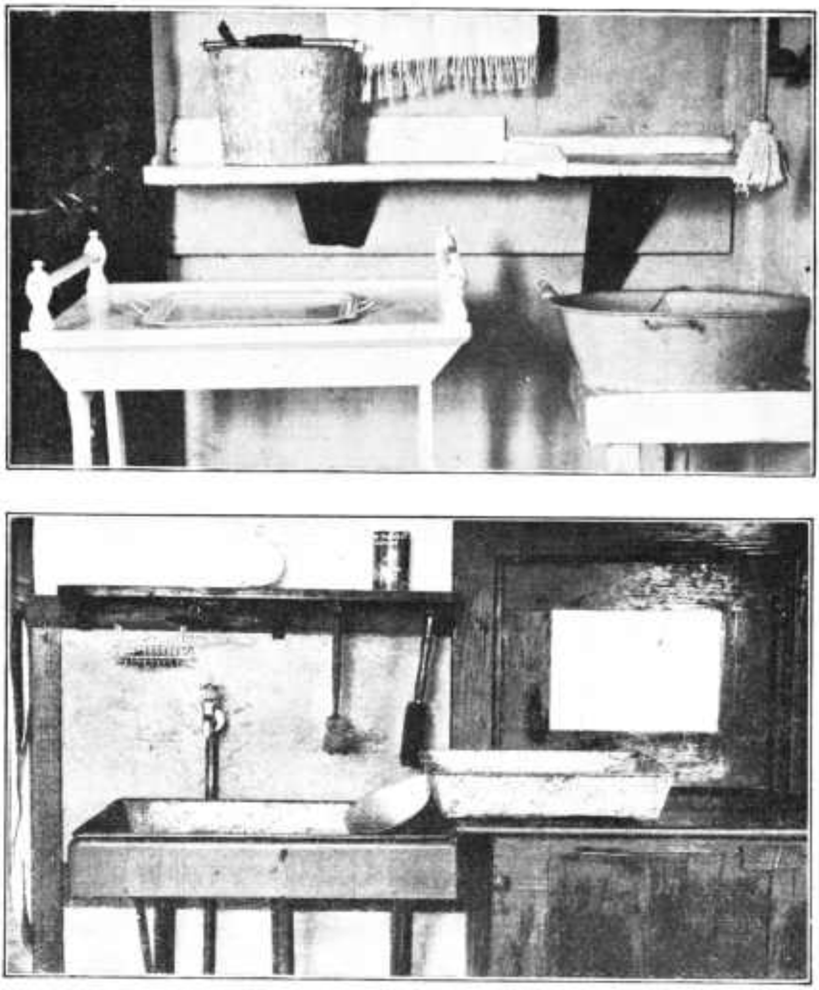

FIG. 3.—Home-made kitchen sinks in Virginia

Upper: Large dish pan partly embedded in concrete within a shallow wooden form or box; the whole is painted white and varnished with a resistant, nonabsorbent varnish

Lower: Large enameled pan embedded in concrete formed as in the upper picture and supported by brackets; has the effect of an apron sink; note the cement plaster backing

Fittings are pieces to join pipes, change directions, and provide openings—for example, couplings, elbows, branches.

Fixtures are appliances for making plumbing of use—for example, kitchen sinks, washstands, bathtubs—these and one to three section laundry tubs are classed as small fixtures; slop sinks, large shower baths, and water-closets are large fixtures.

A faucet, spigot, bibb, or cock is a device for drawing and stopping water.

House drain is the sloping pipe conveying all sewage through or beneath the cellar or basement and extending 5 to 10 feet outside the cellar wall.

House sewer is the house drain extended downhill.

Soil pipe is pipe conveying feces or urine but may take other wastes also.

Waste pipes are small pipe drains from fixtures other than closet bowls and urinals.

A stack is a soil, waste, or ventilating pipe in upright position.

A vent stack is (1) an extension of a soil or waste stack from the branch of the highest fixture to above the roof; (2) a special vent pipe connected with a soil or waste stack below the lowest fixture

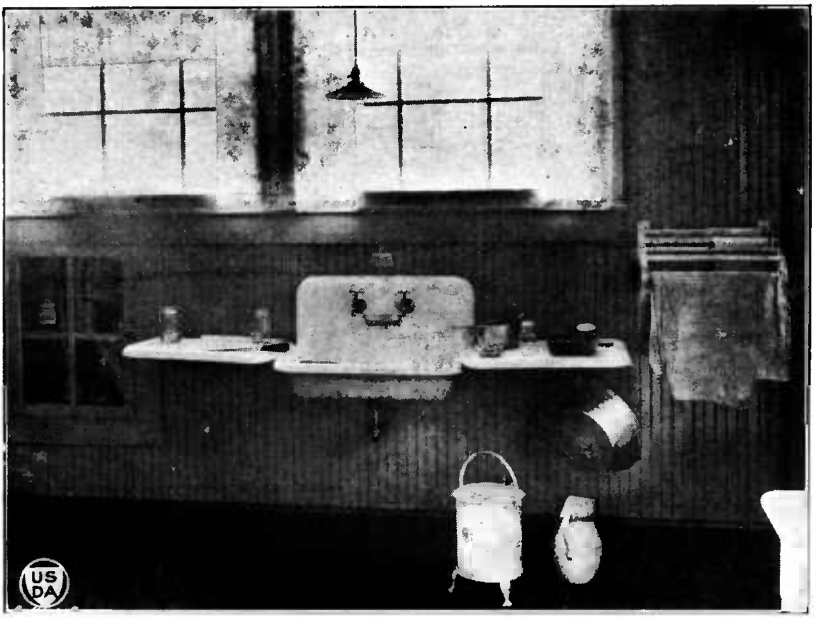

FIG. 4.—A conveniently arranged kitchen with a 1-piece sink

and above the highest fixture or extended independently above the roof.

A trap is a water-sealed bend or vessel in a waste or soil pipe close to or within a fixture to prevent vermin and sewage odor from entering rooms.

A trap vent, back vent, or back air pipe is a short rising pipe from the outlet side of a trap to a vent stack; it promotes flow of the waste water, ventilates the waste pipe, and, by equalizing air pressure, prevents trap siphonage (loss of water seal by suction) and trap blowing (caused by back pressure).

Wrought pipe is weldable pipe, either wrought iron or mild steel, screw-joint pipe usually being understood. To obtain genuine wrought iron it must be so specified.

Size of pipe refers to the nominal inside diameter.

Tubing is thin pipe, generally requiring special threads and fittings and referred to by the outside diameter (O. D.).

The head, fall, grade, or pitch of a pipe is the vertical drop in a given horizontal distance.

Static pressure is the pressure of water at rest; it equals 0.43 of a pound per square inch for each foot of head, or 1 pound for each 2.3 feet of head. The terms low pressure, medium pressure, and high pressure are herein assumed to mean static pressure, less than 20 pounds, 20 to 45 pounds, and more than 45 pounds per square inch, respectively.

Figure 5, a typical 5-fixture job, identifies the plumbing defined.

Tools.—The principal tools used by plumbers are the pouring ladle, calking tools, melting pot, vise, pipe cutter, pipe threader, reamer, pipe wrench, monkey wrench, hammer, file, and measuring tape or rule. The pipe bender and blast furnace are very handy but not absolutely essential. These and other minor tools are shown in Figure 6.

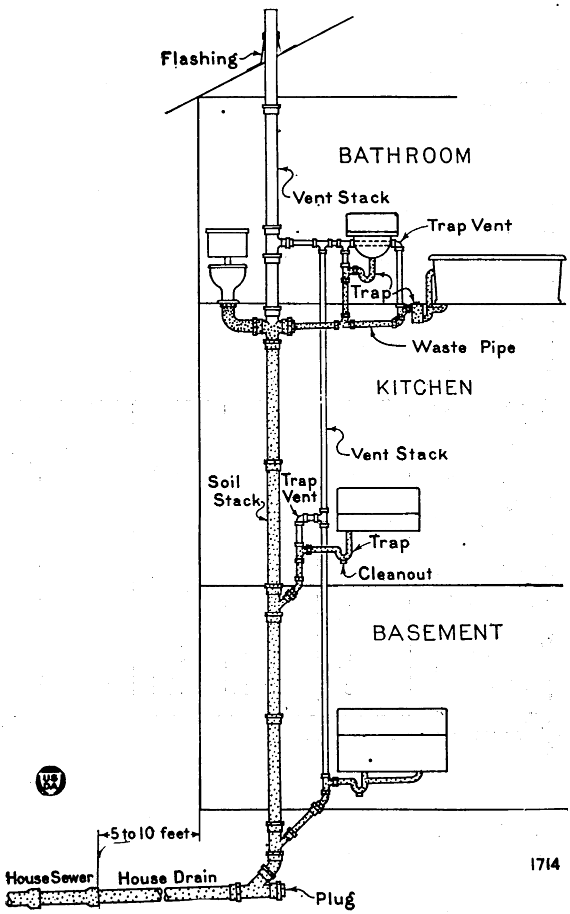

FIG. 5.—A typical 5-fixture job. Drainage pipes are stippled and vent pipes are outlined

PIPE

MATERIALS, DIMENSIONS, WEIGHTS, AND COSTS

WATER PIPE

Lead.—Lead is used extensively for underground water pipes. It is enduring and easily laid, but there is danger of lead poisoning resulting from its use. It should not be used for conveying acid waters or those of swampy or peaty origin. Even hard, feebly active waters, if long in contact with lead, may dissolve amounts sufficient to produce serious cumulative effect. Hence water standing overnight in lead pipe should never be used for drinking or cooking. Where the flow is continuous or where the lead-dissolving power of the water has been determined by a competent chemist, the use of lead pipe may be desirable and the following pipe data are given:

For low and medium working pressure up to 25 or 30 pounds per square inch, lead pipe classed "strong" is suitable; for higher pressure up to 75 pounds, "extra strong" should be used.

TABLE 1.—*Weight and cost of "strong" lead pipe*

	Size of pipe (inches)						
	3/8	1/2	5/8	3/4	1	1 1/4	1 1/2
Pounds per foot	1 1/2	1 3/4	2 1/2	3	4	4 3/4	6
Cost per foot (cents)[1]	17	19 1/2	28	33	44	52 1/2	66

[1] Approximate retail price (subject to variation in different localities) September, 1930.

Wrought.—Galvanized wrought pipe is usually used for farm water piping. It comes in three different thicknesses or weights, as follows: Standard or regular, extra strong, double extra strong. For a given nominal size of pipe, extra strong and double extra strong have the same outside diameter as standard, thickness being gained by making the bore smaller. Standard weight is ample for all ordinary uses, and Table 2 gives dimensions and costs.

TABLE 2.—*Data on standard weight galvanized, wrought iron, and steel pipes*

Nominal size	Actual inside diameter	Weight per foot, threaded and coupled	Threads per inch	Cost[1] per foot	
				Iron	Steel
Inches	*Inches*	*Pounds*	*Number*	*Cents*	*Cents*
3/8	0.493	0.568	18	12 1/2	6 1/2
1/2	.622	.852	14	12 1/2	6 1/2
3/4	.824	1.134	14	16	8 1/2
1	1.049	1.684	11 1/2	23 1/2	11 1/2
1 1/4	1.380	2.281	11 1/2	30 1/2	16 1/2
1 1/2	1.610	2.731	11 1/2	35	20
2	2.067	3.678	11 1/2	47	27
2 1/2	2.469	5.819	8	78	41
3	3.068	7.616	8	104	54

[1] Approximate retail price (subject to variation in different localities) September, 1930.

Wrought pipe comes in random lengths, averaging nearly 20 feet, with ends threaded and carrying one wrought-iron coupling per length. At extra cost, pipe is cut to specified length, with ends plain or threaded, with or without couplings, and the bore reamed and smoothed. Up to 1 1/2 inches pipe is shipped in bundles weighing from 120 to 210 pounds and averaging roughly 168 pounds. Above 1 1/2 inches pipe is shipped loose.

Cast iron.—Cast iron coated with hot coal-tar pitch varnish for underground water pipe is desirable because of its long life. Common hub-and-spigot pipes in 2 and 2 1/2 inch sizes have a laying length of 9 feet, and 3-inch and larger pipes lay 12 feet. Manufacturers test to 300 pounds per square inch, a pressure well within the strength of the pipe. For working pressures up to 100 pounds per square inch suitable weights per length of 2, 2 1/2, 3, and 4 inch pipes are, respectively, 72, 98, 175, and 240 pounds; the approximate costs per foot are, respectively, 32, 44, 58, and 80 cents.

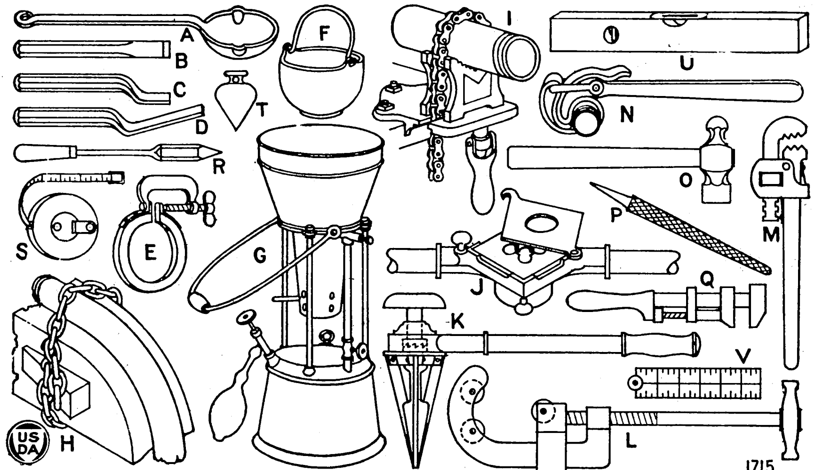

FIG. 6.—Twenty-two plumbing tools: A, pouring ladle; B, cold chisel; C, calking iron; D, yarning iron; E, asbestos or rubber pipe jointer; F, melting pot; G, gasoline blast furnace; H, home-made pipe bender; I, pipe vise; J, stock and die for threading pipe; K, pipe reamer; L, three-wheel pipe cutter; M, 14-inch pipe wrench; N, brass pipe wrench; O, hammer; P, file; Q, monkey wrench; R, soldering copper; S, measuring tape; T, plumb bob; U, spirit level; V, measuring rule. These tools cost about $40

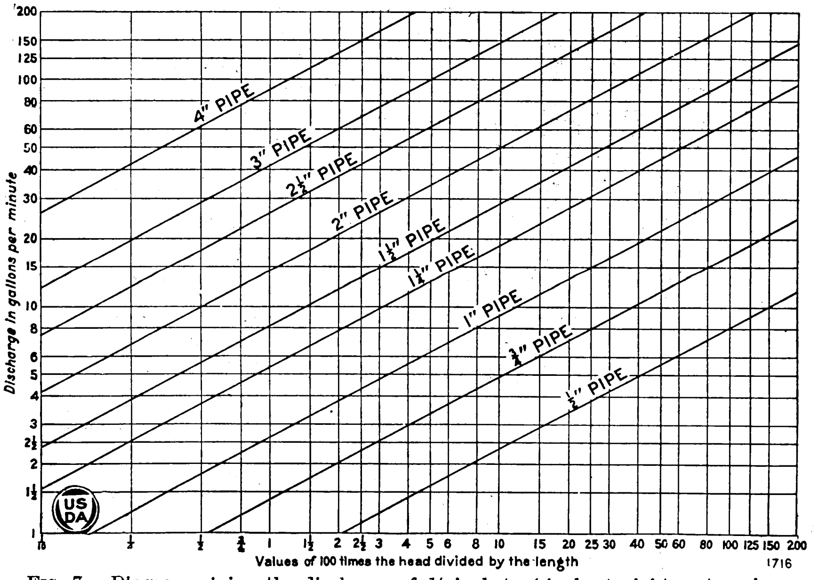

FIG. 7.—Diagram giving the discharge of ½-inch to 4-inch straight water pipes

Directions: Measure the vertical distance in feet from the delivery end of the pipe to the surface of the water in the spring or tank; multiply this distance by 100 and divide the product by the length of the pipe in feet; find this value on the lower horizontal line of the diagram and follow vertically upward to the inclined line or lines showing pipe sizes; from such intersection follow horizontally to the left to find the discharge in gallons per minute.

Example: How much water will be discharged by 128 feet of 1-inch pipe under a head of 32 feet?

Solution: Thirty-two multiplied by 100 equals 3,200; 3,200 divided by 128 equals 25; enter the diagram at 25, follow upward to the line marked 1-inch pipe, and then follow to the left where the discharge is seen to be 15 gallons per minute.

NOTE.—For hydropneumatic tanks the equivalent head is 2.3 feet per pound of gage pressure. Do not use the diagram for pipes shorter than 500 times their inside diameter; thus, for ½-inch pipe the length should be at least 21 feet; for 1¼-inch pipe, at least 52 feet.

Cast-iron pipe in sizes from 1¼ to 4 inches may be obtained with prepared or factory-made joints ready for calking in the field. It is about ¼ inch thick, comes in lengths to lay 5 feet, is tested to 300 pounds per square inch, and is well adapted to farm use because there is no lead to melt and pour. This pipe may be obtained also with ends threaded for standard screw fittings.

Other kinds of pipe.—Corrosion of small steel and iron pipes results in "red water," reduced carrying capacity, and shortened life. Sometimes the bore of wrought pipe clogs or closes long before the wall of the pipe is destroyed. Pipe materials which overcome most of these difficulties are obtainable. Among such pipes are brass, brass or copper-lined wrought, tin-lined lead, tin-lined wrought, and cement-lined wrought. Brass pipe should be medium annealed; for unconcealed water pipes (from fixture to floor or wall), where the pressure is low or medium, tubing of a thickness

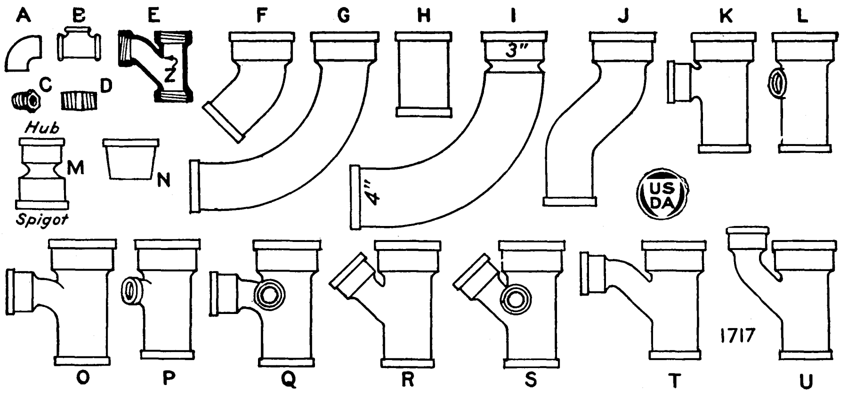

FIG. 8.—Fittings: A, plain elbow or ell, turns one-quarter of a circle or 90 degrees; B, beaded tee branch; C, shoulder bushing; D, shoulder nipple; these four are typical wrought water pipe fittings; E, section of 90-degree long-turn Y branch or TY drainage fitting recessed and threaded for wrought pipe; note that the point Z is below the center line of the inlet pipe, an important feature in soil and waste lines; F, eighth or 45-degree bend, cast-iron, hub and spigot type; G, long-sweep quarter bend; H, sleeve, sometimes used for joining two spigot ends on repair work; I, long-sweep reducing quarter bend, 4-inch spigot, 3-inch hub, often used at the bottom of 3-inch soil stacks; J, offset; K, T-branch; L, T-branch tapped for wrought pipe; M, reducer; an increaser has the spigot on the smaller end; N, plug; O, sanitary T-branch; P, sanitary T-branch tapped for wrought pipe; Q, sanitary T-branch with right-hand side inlet; R, Y-branch; S, Y-branch with right-hand side inlet; T, combination Y and eighth bend or TY fitting; U, upright Y-branch.

varying from $\frac{1}{16}$ to $\frac{1}{12}$ of an inch may be used. Cement-lined pipe for underground work has had considerable local use for more than 50 years and has proved serviceable.

DRAINAGE AND VENT PIPES

House sewer.—The house sewer is usually vitrified clay or concrete sewer pipe 4, 5, or 6 inches in size, depending mainly on the fall. Full information on grading, laying, and jointing is given in Farmers' Bulletin No. 1227, Sewage and Sewerage of Farm Homes, which will be mailed free on request by the Department of Agriculture.

House drain and connections.—Within buildings all drain, soil, waste, and vent pipes, except short lead or brass connections to traps and water-closets, are generally iron or steel.

Cast-iron soil pipe.—Cast-iron soil pipe should be used underground. It is made mostly in two thicknesses or weights—standard and extra heavy. It is sold by the foot, inside diameter always being understood when referring to size. It has hub-and-spigot joints, comes in lengths to lay 5 feet, and is tested by manufacturers to 50 pounds per square inch. It comes plain or coated with tar or oil. Plain pipe is generally used above ground because defects are more readily seen. Coated, extra heavy pipe is generally used under ground, being less subject to corrosion and more substantial. Table 3 gives data on cast-iron soil pipe.

TABLE 3.—*Data on cast-iron soil pipe*

[Single hub, 5-foot lengths]

Class	Inside diameter	Thickness of wall	Hub		Weight per length	Cost per foot [1]
			Inside diameter	Depth		
	Inches	*Inches*	*Inches*	*Inches*	*Pounds*	*Cents*
Standard	2	$\frac{1}{8}$	(2)	(2)	18	19
Do	3	$\frac{1}{8}$	(2)	(2)	26	26
Do	4	$\frac{1}{8}$	(2)	(2)	35	34
Do	5	$\frac{1}{8}$	(2)	(2)	45	43
Extra heavy	2	$\frac{1}{4}$	$3\frac{3}{16}$	$2\frac{1}{4}$	$27\frac{1}{2}$	25
Do	3	$\frac{1}{4}$	$4\frac{3}{16}$	$2\frac{1}{2}$	$47\frac{1}{2}$	38
Do	4	$\frac{1}{4}$	$5\frac{3}{16}$	$2\frac{3}{4}$	65	51
Do	5	$\frac{1}{4}$	$6\frac{3}{16}$	$2\frac{3}{4}$	85	68

[1] Approximate retail price (subject to variation in different localities) September, 1930.
[2] Approximately same as for extra heavy pipe.

Standard pipe has considerable use on farms but due to its light weight is more apt to be broken during shipment, handling, cutting, and calking. Care is required to make an installation pass the usual tests, and the piping is easily broken by settlement or accident. As between standard and heavier, the saving in metal may not offset the disadvantages of the lighter pipe. Medium-weight pipe is now little used.

Cast-iron soil pipe has decided advantages in farm plumbing, especially for stacks. It is long-lived and great exactness is not required in planning and roughing-in the work. The pipe needs no reaming and is readily cut to make repairs or changes. The numerous joints take care of expansion and contraction, each permitting a little slip. A leaky joint, if accessible, is easily repaired with calking tools.

Wrought.—Wrought soil, waste, and vent pipes may be black or galvanized, the latter being most used. It should be standard weight as given in Table 2. Wrought pipe has these advantages over cast iron: It is lighter, stronger, more easily handled, and the joints are fewer, more easily made, and can not pull apart. When installed it is better looking, takes less space, and requires less support and less notching of joists and studs. The disadvantages are the difficulty in making repairs or changes and the shorter life of the pipe.

Brass.—Nickel-plated brass tubing is largely used for unconcealed wastes and vents (from fixture to floor or wall) and for closet flush

pipes. Thicknesses vary from 1/50 to 1/25 of an inch, the thicker being preferable.

Lead.—Lead waste and vent pipe should be about $\frac{1}{8}$ inch thick and weigh per running foot as follows: $1\frac{1}{4}$-inch, $2\frac{1}{2}$ pounds; $1\frac{1}{2}$-inch, 3 pounds; 2-inch, 4 pounds; $2\frac{1}{2}$-inch, 5 pounds; 3-inch, 6 pounds; 4-inch, 8 pounds. Where plumbers are available, lead pipe is still used extensively, being smooth, lasting, pliable, and easily worked. However, it must be well supported to prevent sag, it is easily punctured by nails, is sometimes gnawed by rats, and care is necessary to produce soldered or wiped joints of smooth bore.

CORROSION AND LIFE OF PIPE

Pipe and fittings are made with greater thickness than that required to sustain the water pressure. This is to guard against corrosion and the strains caused by cutting, threading, and joining pipes and expansion and contraction of pipe lines. All waters and soils corrode, the action being more noticeable at joints and in iron or steel pipe of poor quality. Acid or alkaline water or soil corrodes pipe faster than neutral; soft water faster than hard; ground water faster than surface; hot water faster than cold; wet soil faster than dry; salt, clay, or cinder soil faster than sands or gravels; polluted soil faster than clean; foul air faster than pure; a large flow faster than a small; high pressure faster than low. Steel and wrought iron are corroded faster than cast iron, brass, or lead; horizontal lines faster than vertical. Electrolysis and local galvanic action increase corrosion, hence the importance of not grounding telephone and other electric lines to plumbing and of using pipe and fittings of like composition.

Under average conditions small black wrought pipe in the ground should last 10 to 20 years; galvanized steel, 15 to 30 years; galvanized wrought iron, 20 to 40 years; lead and cast iron, 40 to 75 years. It is, however, not uncommon to find lead and cast-iron pipes sound after 80 to 100 years, and, except for slight external corrosion, cement-lined black wrought-iron pipe has been found in perfect condition after 40 years in the ground. Steel pipe coated inside and outside with 1:1 cement mortar has been found intact after 60 years.

Water containing much hydrogen sulphide, carbonic acid, or oxygen may dissolve galvanizing in a few months. Wiped joints in lead pipe have become porous and leaky in a few years. Steel pipe has become worthless in 5 years, wrought iron in 10 years, and cast iron in 15 years. But such instances are exceptional.

Within buildings hot-water pipes usually fail first; sometimes horizontal runs fail or clog within 10 years. Cold water, drainage, and vent pipes should last as long as the average farm building.

PIPE SIZES

Water pipe.—Pipe sizes are governed by the available pressure and the desired rate of delivery. Larger pipes are now used than formerly, the reasons being greater delivery, less clogging, less robbery by other faucets used at the same time, slower velocity and less hissing noise, longer life of the pipe, and cleaner wastes and drains. Medium pressure is better than high, lessening waste of water, wear

and tear of plumbing, and air bubbles in the water. Where the pressure exceeds 80 pounds per square inch a pressure regulator should be placed near the cellar wall and on the house side of the branch to the sill cock, leaving full head on that fixture.

A reasonable service in an ordinary home requires discharges not less than the following:

	Gallons per minute
Kitchen sink, 1 faucet	3
Kitchen sink, 2 faucets	5
Laundry tub, 2 faucets	5½
Sill cock	5½
Bathroom	10

All of these fixtures are seldom used at one time. On average days the maximum draft of a family of six is about 10 or 12 gallons per minute for short periods, but frequently fixtures are used in such combinations as to increase the draft to 18 gallons per minute. Larger establishments cause larger maximum drafts, but seldom is the increase at all proportional to the figure given above for six persons.

A ½-inch kitchen faucet (inlet 0.53 inch and outlet 0.48 inch) tapped into the side of a barrel of water 2.3 feet from the top is under a head of 1 pound, and discharges, when fully opened, 3 gallons per minute; a ⅝ or ¾ inch faucet does very little better. If the faucet were at a distance from the barrel, the discharge would be less, but could be made to equal that stated by using either a higher barrel or larger pipe.

The smallest pipe to lay from a spring, tank, or reservoir to a house is the one that will deliver the probable maximum draft to the central point of use and still leave 1 or 2 pounds head on the highest faucet. That central point is usually the bathroom or kitchen sink, and the size of the house-supply pipe should be determined with that in mind. The problem can be easily solved by the use of the diagram and directions in Figure 7.

Poor service is often due to the use of small leading pipes within the house. Such situations are not greatly improved by large faucets and fixture pipes which add to the cost and make the plumbing clumsy. From house supply to bathroom, there should be little reducing of size. Table 4 indicates suitable sizes for branch and fixture pipes when supply pipes are of the sizes shown. The smallest size of fixture pipe indicates the size of faucet, except that ⅜-inch pipe may have a ⅜-inch faucet, and high-pressure wash-basin connections of brass may reduce in the last few inches to take ¼-inch faucets.

TABLE 4.—*Size of water pipes (inches)*

Class of pressure	House supply	Bath-room	Bath-tub	Washstand: Pipe con-cealed	Washstand: Pipe exposed	Closet tank: Pipe con-cealed	Closet tank: Pipe exposed	Kitchen sink	Laun-dry	Sill cock
High	¾	¾	½	½	⅜	½	⅜	½	½	½
Medium	¾ or 1	¾	½	½	⅜	½	⅜	¾	¾	¾
Low	1 or 1¼	¾ or 1	½	½	⅜	½	⅜	¾	¾	¾

The above classification of pressure is merely suggestive. Pipe lengths and the number and character of fixtures must always be considered. For example, a distant watering trough having a float-controlled valve may be well served with ½-inch pipe; with an ordinary faucet a ¾-inch pipe may be necessary. A spray head may be well served with ½-inch pipe, whereas a large shower bath or a long run may require ¾-inch pipe. In general, branch runs longer than 25 feet or supplying two or more small fixtures should be ¾-inch pipe. An ordinary house supplied from an attic tank should use pipes not smaller than those of the last line in Table 4; to the bathroom 1¼-inch pipe would be still better.

Drainage and vent pipes.—Safe sizes of soil, waste, flush, and vent pipes are shown in Table 5.

TABLE 5.—*Size of soil, waste, flush, and vent pipes*

Pipe and condition	Size
	Inches
House drain—ordinary house, no rainwater	4
Soil stack	3
Water-closet bend and branch to soil stack	3 or 4
Water-closet flush, low tank, O. D. tubing	2
Waste—concealed, pitched, or vertical:	
Slop sink or large shower bath, each	2
Kitchen sink, one laundry tub, shower head, bathtub, washstand or similar, small fixture, each	1½
Two small fixtures	1½
Three to five small fixtures	2
Slop sink, kitchen sink, or floor drain buried in ground or concrete	3
Waste—exposed, pitched or vertical; O. D. tubing:	
Kitchen sink, or 1, 2, or 3 section laundry tub or combination sink and 1 or 2 section laundry tub with continuous waste and trap	1½
Bathtub, O. D. tubing	1⅜ or 1½[1]
Washstand, O. D. tubing	1¼ or 1½[1]
Traps—no smaller than entering waste; minimum seal, 2 inches.	
Vents—Extension of soil stack	3
One to five small fixtures	1½
Water-closet (if another is above), either with or without the usual small fixtures	1½

[1] The larger size is preferable.

FITTINGS

Figure 8 shows the principal fittings. They should be of similar metal and thickness as the pipe. Sizes refer to the nominal inside diameter of the connecting pipes, the run being given first and the branch last. For example, the tee, $\frac{3}{4}\ \overset{\frac{1}{2}}{\perp}\ \frac{3}{4}$ is read ¾ by ¾ by ½, or shortened to ¾ by ½ T.

Fittings for wrought water pipe should be galvanized or lined like the pipe itself. Plain galvanized malleable iron fittings are suitable for low-pressure indoor pipes but the stronger beaded fittings should be used for higher pressures and underground work.

Drainage fittings for wrought pipe have enlarged ends forming a recess about ¾ inch deep. The fittings have the same bore as standard pipe which, when screwed in, butts against the shoulder, forming a smooth continuous waterway. Long sweep elbows and TY fittings should be used on all drainage lines. Square elbows and T and TY branches are tapped about 5 threads, pitching the inlet pipe ¼ inch per foot. Ordinary beaded fittings are used on vents.

JOINTS AND CONNECTIONS

Joints require special care since they are the weakest parts. Hub and spigot joints are made by ramming with a yarning iron a twisted strand of oakum or jute into the bottom of the joint space, filling at one pouring with molten pig lead, and driving with hammer and calking tools. Oakum or jute is used in cast-iron soil pipe, leaving about 1 inch for lead, $\frac{1}{2}$ to $\frac{3}{4}$ of a pound of which is required per inch of pipe bore. Jute is used in cast-iron water pipe, leaving about 2 inches for lead, about $1\frac{3}{4}$ pounds of which are required per inch of pipe bore. Using a calking tool pointed about $\frac{3}{16}$ by $\frac{3}{4}$ inch, the joint is gently driven all around several times. This avoids splitting the hub and evenly compacts the lead. The next driving is harder and the joint is smoothly finished with the calking tool that most nearly fits the space without binding. It is sometimes very convenient to use lead wool in loose rope form, calked cold, instead of molten pig lead.

FIG. 9.—Cutting cast-iron soil pipe with a cold chisel

FIG. 10.—Use of a yarning iron to pack a strand of oakum or jute into the bottom of the joint space

Cast-iron pipe is cut with a wheel pipe cutter or a cold chisel, the latter requiring more care and labor. To cut standard cast-iron soil pipe with a cold chisel, first cut or groove the pipe squarely around with a three-cornered file. The pipe, at the groove, is rolled on a piece of 2 by 4 laid flat and the cold chisel lightly tapped to circle the pipe several times. Heavy pipe may be grooved or impressed with the cold chisel and heavier blows may be struck. If the groove is formed squarely around the pipe, an even break usually occurs after circling two or three times. Figures 9, 10, 11, 12, and 13 show the methods above described.

Wrought pipe is cut with a hack saw or a wheel or knife pipe cutter, twisting the handle an eighth to quarter turn to the right each time around the pipe. If the cutter is too tightly set, the wheels cause a deep burr in the pipe bore. It is especially important in water and drainage piping that the burr be removed with a reamer.

Threads are cut with a steel die held in a stock carrying a guide with bushings adapted to different sizes of pipe. The guide and bushings prevent cutting crooked threads. Dies are marked with the size of pipe they thread. The mark must face the operator, who rotates the stock clockwise, the direction of making up all right-hand threads. The die should be sharp; if dull or broken the thread and joint are likely to be defective. To make the die take hold of the pipe and not strip it, the end should be free of oil and the stock must be pushed hard. As soon as the die catches, plenty of good lard oil or crude cottonseed oil should be applied to the cutting, otherwise the thread will be poor and the die may be spoiled. The stock is turned until the end of the pipe is about flush with the face of the die. Further threading is not only useless but may be a hindrance to making up tight joints. Solid dies for $\frac{1}{2}$ to $1\frac{1}{2}$ inch pipe are $\frac{3}{4}$ inch thick, being a little less for very small pipes and more for large ones. Thus seven or eight effective, taper threads are cut and about half of these may be run by hand into a fitting or valve. Tightness is secured by turning the last three of four threads with a pipe wrench. Graphite or red lead and linseed oil is used on the male (pipe) thread to lessen friction and promote tightness of the joint. There should be few or no threads outside the fitting because their presence weakens the pipe and favors early corrosion and leakage. Such threads may be painted with black asphaltum to lessen corrosion, but it is better to use an adjustable die which permits cutting a thread to screw completely into the fitting. The methods above described are shown in Figures 14, 15, and 16.

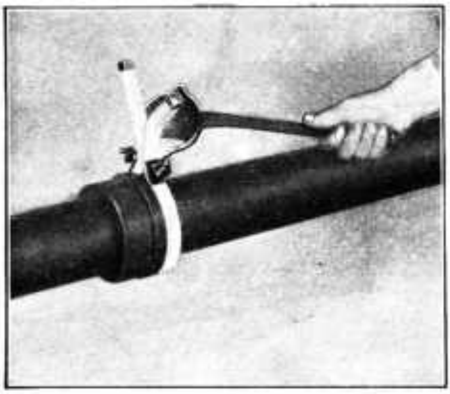

FIG. 11.—Horizontal pipe line—use of an asbestos pipe jointer clamped at the top and firmly pressed against the hub to prevent escape of the molted lead

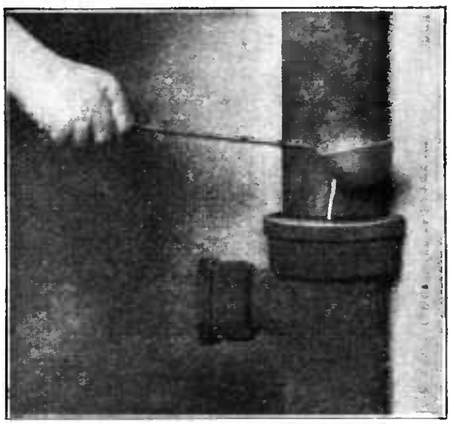

FIG. 12.—Vertical pipe line—pouring melted pig lead into a hub to fill the joint space

Figure 17 shows a few special joints. Figure 18 shows water-closet connections in common use. The flanged lead and putty joint is very simple, but is prohibited by many local ordinances. Figure 19 shows how the lead bend is beaten out flat with a hammer. The flattened end and the entire bottom of the bowl are smeared with red lead. About 2 pounds of putty are spread over the bottom of the bowl,

using care to more than fill the circular groove around the horn. The bowl is then set in position and heavily pressed, first on one side and then on the other, to obtain a full, even bed of putty under the whole bottom. The bowl is then tightly screwed to the floor. Figure 20 shows a cast-iron flange flat on the floor and in correct position for inserting the brass bolts, placing the gasket or putty, and screwing down the nuts to hold the bowl.

FIG. 13.—Calking a lead joint to make it air-tight and water-tight

LOCATION OF PLUMBING

A plan or sketch showing pipe sizes and locations and general arrangement of fixtures should always be made before spending a penny. Simple houses make for simple, easily installed plumbing, as illustrated in Figure 5. Laundry, kitchen, and bathroom are over one another, lessening piping and making it direct and compact. Other reasons for having the bathroom over or near the kitchen are that with this arrangement there is less chance for freezing and less objection to leaks or noise from bathroom fixtures. Every bathroom should have a window, skylight, or ventilating duct to the outer air.

FIG. 14.—Cutting wrought pipe

With respect to bathroom fixtures, the best location of the soil stack is back of the water-closet or a little toward the washstand, as shown in Figure 5. Placing the fixtures along one wall saves pipe. Figure 21 shows the position of the fixtures in six bathrooms and what may be accomplished in small and medium areas. Figure 22 shows how attractive the interior of a 5-foot square bathroom may be made.

The kitchen sink should be located to insure light, air, and fewest steps. It should be located so that a drain board at both ends is possible, as shown in Figure 4. It should be close to the cupboard, thus saving steps and a second handling of the wiped dishes. It should be near the pantry and not so close to the kitchen range as to cause discomfort. Nearness to the soil stack means less piping. Plumbing

should be safe from frost. No unprotected pipes should be placed in outer walls of poorly heated houses in cold climates. No pipes should be embedded in masonry; a recess or channel may be left or the piping placed in partitions as in frame buildings. Often where it is not feasible to carry piping in partitions, the stacks are run through niches or closets, placed in a box with removable panels, or left exposed.

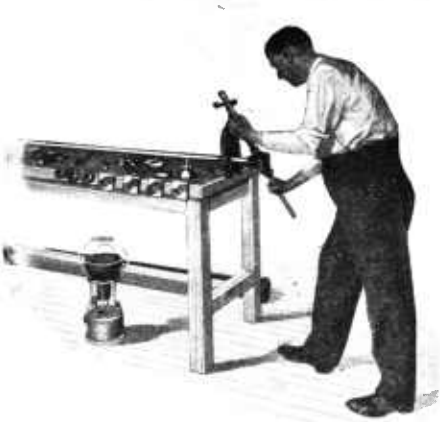

FIG. 15.—Threading wrought pipe—position of the operator when pushing the stock and die to start the thread

ROUGHING-IN

In new houses the pipes that will be concealed should go in after the framing is erected. In old houses it is equally important to know how pipes must run to meet fixture openings. Roughing-in is the installing of the pipes to floor and wall lines. Manufacturers of fixtures and connections prepare roughing-in measurements of their products. There are no fixed standards, though the variations among manufacturers are small. When the householder decides on his fixtures, he should obtain the roughing-in measurements for those particular fixtures. Figure 23 shows typical roughing-in measurements of a sink and a water-closet. Sinks and laundry tubs are set higher than formerly, 30 to 31 inches from the bottom of the sink to the floor is considered a good average height (see fig. 29). For the average worker the top rim of the sink or tub should be placed so that the worker does not stoop from the shoulders but bends at the hips.

The house drain is generally installed first and the soil stack is carried upward from it. The fittings for branches should be assembled in correct position and the length of the pipe to be cut to fit should be measured with a tape or stick. The work should proceed step by step. After one piece of pipe with fitting permanently attached is in place, measurement should be made to reach the next fitting. The procedure for water pipes should be similar. Methods of supporting and roughing-in pipes are shown in Figures 24, 25, 26,

FIG. 16.—Threading wrought pipe—after one or two threads are cut, pushing is unnecessary and the operator may turn the stock as above indicated

27, and 28. All piping (except traps) should grade to drain back to the cellar, water pipes wasting at the stop and waste just inside the cellar wall, and soil, waste, and vent pipes bleeding into the house drain. For soil and waste lines, the slopes per foot should not be less than $\frac{1}{4}$ inch; for vents, $\frac{1}{8}$ inch; for water pipes, $\frac{1}{10}$ inch. There should be no sags or pockets in which water can stand and freeze.

FIXTURES

The most popular sinks, bathtubs, and washstands are enameled cast iron (white glassy coating fused on a thin cast-iron shell). Closet bowls and tanks are generally vitreous ware (fused China clay) $\frac{1}{2}$ to $\frac{3}{4}$ inch thick; the material closely resembles ordinary white table crockery. Solid porcelain, so called, sometimes used

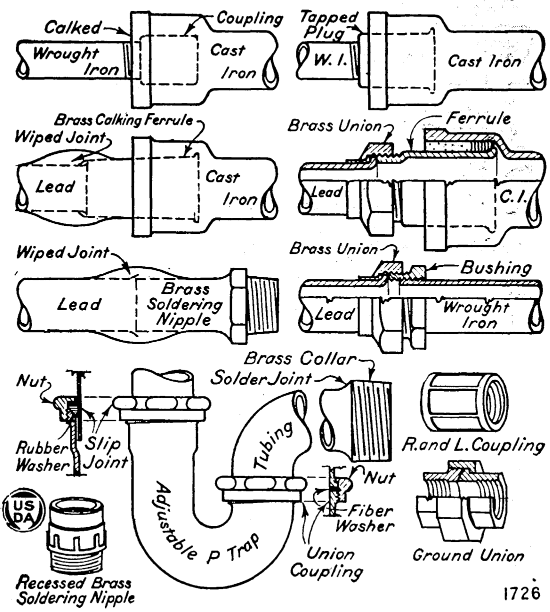

FIG. 17.—Methods of joining different kinds of pipe. The right and left coupling and ground union are used to join threaded male ends on water and vent pipes. To connect two pipes with a right and left coupling, tightly screw the coupling on the right-hand thread and mark the distance with chalk; take off the coupling and count the threads covered; screw the coupling on the left-hand thread and count the threads covered; screw the coupling on the pipe end having the greater number of threads until an equal number of threads is exposed on both pipe ends; engage the free end, turn the coupling and both ends will tighten equally.

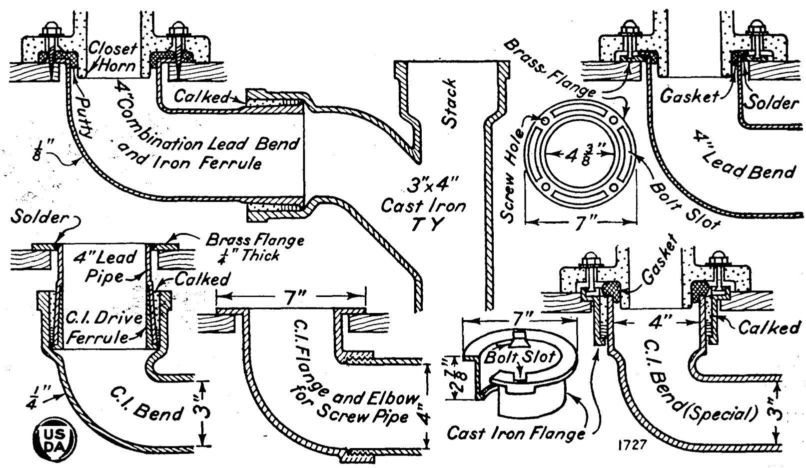

FIG. 18.—Methods of making water-closet connections

for sinks, laundry, and bath tubs, is very different from vitreous ware. The material beneath the glazing is more absorbent, fixture walls are

$1\frac{1}{2}$ to 2 inches thick, and the fixtures are heavy and costly; like all earthenware they must be handled and installed with great care. The number, size, and character of the fixtures should always be in keeping with the surroundings and the pocketbook; simple, unornamented white fixtures are best. Generally, the prices quoted are close, retail, cash figures and do not include freight. The cost of plumbing fixtures, like many other products, has a wide range with differences in design, materials, durability, and finish. Size refers to the overall (outside) width and length.

FIG. 19.—Beating out the end of a lead bend to form a flange

Sinks.—Sinks come in plain and enameled cast-iron, painted, galvanized, and enameled steel, soapstone, slate, glazed fire clay, and vitreous ware. A fair size is 20 by 30 or 36 inches. Steel and flat-rim iron sinks are supported by iron, steel, or brass wall brackets. Stone and other heavy sinks are supported by frames or by legs and wall fastenings. The fastenings for stone and apron sinks may be iron or brass angles screwed or bolted to wall and fixture, but generally the leg is braced direct to the wall by a horizontal iron strap with angle. One-piece enameled sinks with backs are fastened by two or more lugs in the rear top which engage concealed iron hangers screwed through to the studs, to "grounds" firmly nailed in between the studs, or to a board screwed to the studs. The board should be flush with the plastering. Expansion bolts are used in brick and concrete walls; toggle or through bolts in terra-cotta walls. Small sinks are supported wholly by the hangers. Sink tops should be set level, the same as other fixtures.

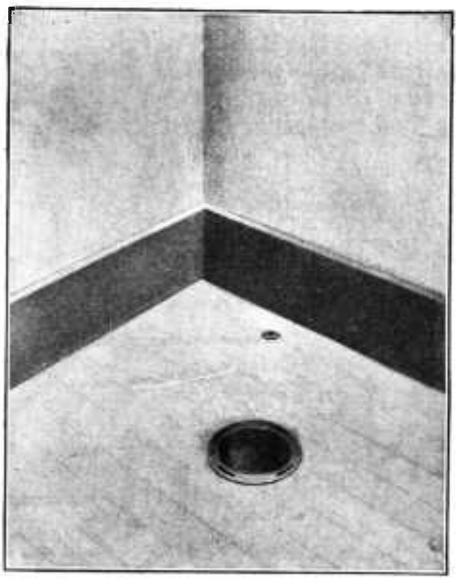

FIG. 20.—Cast-iron flange in position for fastening the bowl

The best sinks are enameled, roll-rim, or apron, with 12-inch high integral back hollowed for supply pipes, and one or two drain boards

similar to that shown in Figure 29. This sink has adjustable legs, which permit varying the height from the floor, and combination swing faucet, which permits drawing hot, cold, or tempered water and aids in rinsing and filling dishes. It is well to use a hardwood mat to protect the sink bottom.

Sinks 20 by 30 inches, without trimmings, cost approximately as follows: Flat rim, cast iron, painted inside and out, $4; steel or cast iron, enameled inside, painted outside, $6 to $9; enameled, roll rim, integral back, $14.25; soapstone, $16.35; slate, $17.55.

Laundry tubs.—Laundry tubs are made of artificial stone and of similar materials as sinks. White or light shades are best, because

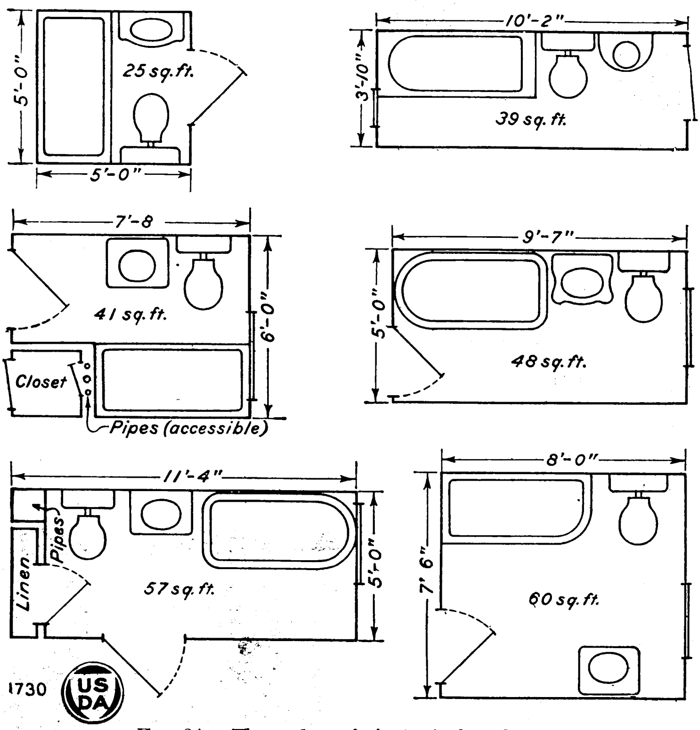

FIG. 21.—Floor plan of six typical bathrooms

dirt, either on the clothes or the tub, is more readily seen. A plain, two-section artificial stone tub 24 by 48 by 15½ inches with legs costs $14.60; the same with 6-inch high back, $20; soapstone and slate, $20 to $25. A stub compression faucet costs 75 cents. A double laundry faucet with swing spout is very handy for two-section tubs and costs $3.50.

Bathtubs.—A fair-size bathtub is 30 by 60 inches. A 3-inch roll rim, enameled inside, painted outside, width and length over rim as above, 22 inches high on feet, costs $28 to $43; for usual trimmings add $8 to $10. A built-in corner pattern tub 30 by 60 by 17 inches, enameled inside and outside, tiling about one-half inch into floor and two walls, costs with trimmings $65 to $93. A 5-foot enameled tub,

recess pattern, concealed pipes (see fig. 22) costs with trimmings $85 to $108. Tubs of the last two types prevent dirt from collecting under or back of them, and lighten the work of cleaning the bathroom. Tenant farmers whose stay on a given farm is of indefinite

FIG. 22.—Attractive bathroom interior, 5 feet square

length may find a portable galvanized steel bathtub and water heater a great convenience.

Washstands.—A fair size washstand is 18 by 24 or 20 by 24 inches with 12 by 16 inch bowl. Corner stands are sometimes used, a fair

size being 19 by 19 inches on each wall, with bowl 11 by 14 inches. Washstands are supported like sinks; those with flat top stand out 1½ inches from the wall and have wall brackets, concealed supports, or a leg or pedestal and braces to the wall; those having integral slab, back, and bowl are supported by a concealed hanger, by wall brackets, or by a leg and brass wall clamps. A half-circle, roll-rim, enameled one-piece washstand 17 by 19 inches, 6 inch-high back, with trimmings to wall, costs $13 to $20. A square enameled one-piece apron washstand 18 by 24 inches (a popular size), 10 inch-high back, with trimmings to wall, costs $20 to $29. The top is of good shape and size to set toilet articles during their use.

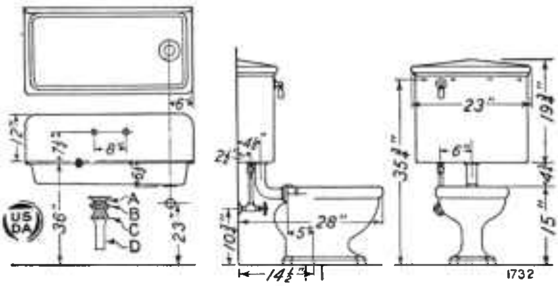

FIG. 23.—Typical roughing-in measurements of a flat-rim kitchen sink with detachable back and a reversed-trap, siphon-action water-closet; the distances are not fixed standards but are merely illustrative of particular types of fixtures from one manufacturer. A, detail of strainer piece; B, lock nut and washer; C, coupling nut; D, tail piece; the strainer has nineteen ¼-inch holes and may be easily detached when it is desired to use a rubber stopper in the sink outlet

Water-closets.—Water-closet bowls are generally vitreous ware, with trap formed inside and the flush siphoned downward through the floor. The area and depth of standing water should be large; the dry surface that can soil should be small. Figure 30 shows sections of typical siphon-action and siphon-jet bowls. Ordinary siphon-action bowls (see fig. 22) have the long, curved-out leg in front; they give good service and cost less than the other types. Reversed-trap siphon-action and siphon-jet bowls have the long leg in the rear, improving their appearance; the operation of both types is quieter and stronger than in the ordinary siphon-action bowl. Siphon-jet bowls are readily recognized by the jet opening in the inside bottom of the trap and by the two rear outside swellings over the passage to the jet.

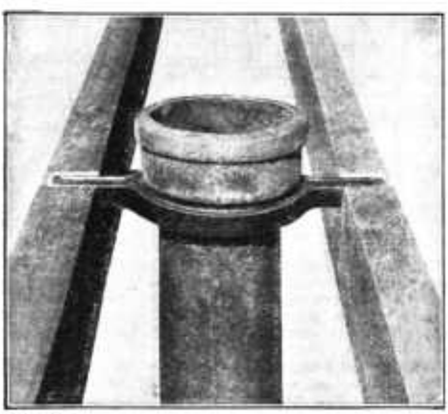

FIG. 24.—Cast-iron pipe rest notched into two floor joists

The flush tank is usually vitreous ware, but enameled iron, and wood lined with copper, lead, or zinc are used also. Vitreous and wood tanks are supported by brackets or by two 1½ by 1½ by ¾ inch wide steel or cast-brass angles at the bottom and by two or three ½-inch iron hooks, lag screws, or bolts through holes in the top of the back. All fastenings must go into solid support. Enameled tanks have wall hangers and support-

ing lugs on the back as shown in Figure 31. A fair size tank is 18 or 19 inches long, 6 inches wide, and 16 inches high inside; the flushing depth is 9 to 10 inches and the flush is 4 to 5 gallons. The flush should occur in 7 to 10 seconds, the shorter time being best. If the valve does not rise sufficiently from the seat to flush quickly the trouble is easily overcome by shortening the loop of the long lift wire shown in Figure 31. When in good working order there is little rise of water in the bowl. A siphon-action vitreous bowl with white wooden seat and vitreous tank complete costs $29 to $49; the same outfit, except with siphon-jet bowl, costs $36 to $69; an oak tank costs $10 to $11, and enameled and vitreous tanks $14 to $16.

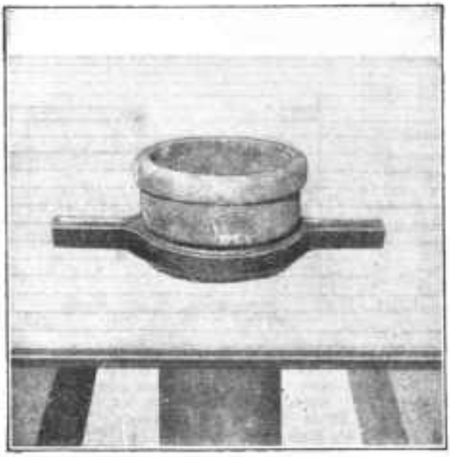

FIG. 25.—Cast-iron pipe rest on the top of a floor

The most widely used flushing valve is a 2½-inch rubber or copper and rubber ball which rises from and drops into a hollowed seat. Most valves give more or less trouble with age because the ball gets out of shape and fails to seat properly; or because slime and wear of the working parts or failure of the lift wire to work straight up and down in the guide holder causes the ball to stick and remain up when it should drop to its seat. Another type of valve consists of a thin flat disk with leather seating washer. The float is generally a hollow copper or glass ball about 5 inches in diameter. Glass floats are of more recent introduction and, being noncorrosive, are very desirable but are more liable to be broken. Most of the tank mechanism is under water and deteriorates rapidly; it gets considerable rough use and little or no attention until out of order. Worn-out rubber balls and leaky water-logged floats should be promptly replaced with new ones; the cost is small. The handle and lever mechanism should be simple and easily operated; the guide holder should be adjusted to keep the lift wire plumb.

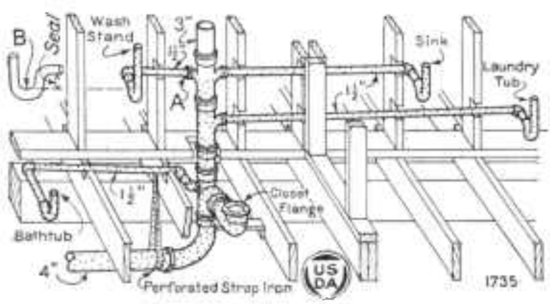

FIG. 26.—Supporting and roughing-in a simple, one-pipe system—a very economical method for bungalows and cottages with fixtures on one floor and near the soil stack. Note three points: (1) There are no back vents; (2) all small waste pipes enter the stack above the closet branch, thus preventing the water-closet from siphoning the small traps; (3) in no instance is the inside bottom of the waste pipe at the stack (point A) lower than the dip of the trap (point B), thus preventing self-siphonage of the trap; this provision limits the length of the waste; for example if the trap seal is 2 inches and the slope of the waste is ¼ inch per foot, its length should not exceed 8 feet (2 divided by ¼ equals 8) and less would be better

A seat-operated, inside enameled closet for outhouses and other freezing situations is shown in Figure 32 and costs $18.

Shower baths.—Many homemade shower heads are failures because they are made of corrosive metal with too many large holes. A small head with $\frac{1}{32}$-inch holes (about the size of a medium pin) saves water and adds to the force and effectiveness of the shower. A nickel-plated brass head with pipe and wall bracket support and rubber tube to fit any ordinary double bathtub faucet costs $4; the same with 24-inch nickel-plated curtain ring and curtain costs $9 to $10. At greater cost a shower may be permanently connected with the bathtub supply or with visible or concealed wall pipes having a hot and cold control valve within a stall or receptor with trapped floor drain.

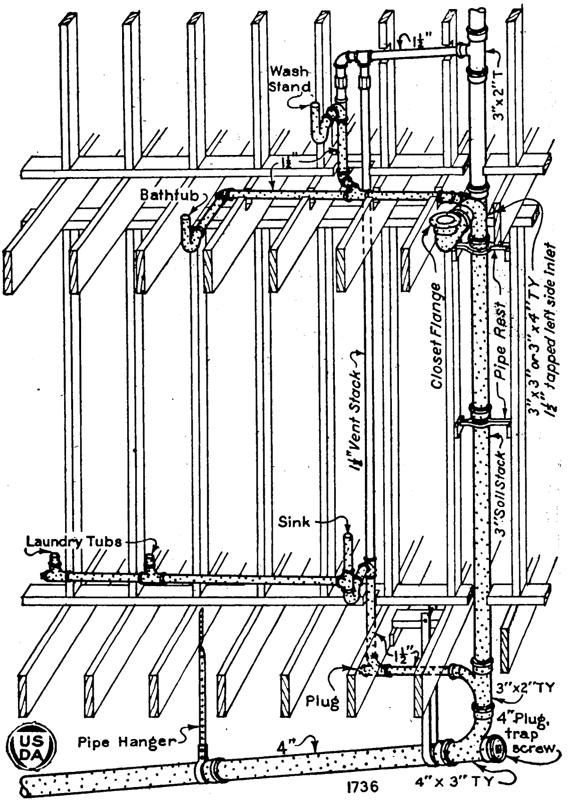

FIG. 27.—Supporting and roughing-in a simple two-pipe system having continuous wastes and vents; the most effective way of venting traps. Drainage pipes are stippled and vent pipes are outlined

HOT WATER

Hot water is necessary in every home. Pipes must be under pressure and there must be a heater—coal, wood, kerosene, gasoline, natural or artificial gas, or electric. There is usually a hot-water storage boiler or tank. The operating principle is that hot water is lighter than cold water and rises; the cold water sinks to occupy its place, thus creating circulation. The secret of success is to connect and pitch the pipes to make the circulation sure and easy. Humps or air pockets must be avoided.

The device most used for heating water is a hollow iron casting lining one or more sides of the fire box in the kitchen range. Western people call it a water front; eastern people call it a water back. The ordinary straight water back is brick shaped, has walls about ½ inch thick with two tappings for ¾ or 1 inch pipe, and is tested to 250 pounds per square inch; its usual position is in the left side of the firebox opposite the oven. For large supplies **L** or **U** shaped

backs are used. Instead of a water back, a coil of two or four pieces of black wrought pipe joined by return bends is sometimes installed in the left side of the firebox. The capacities of water back and

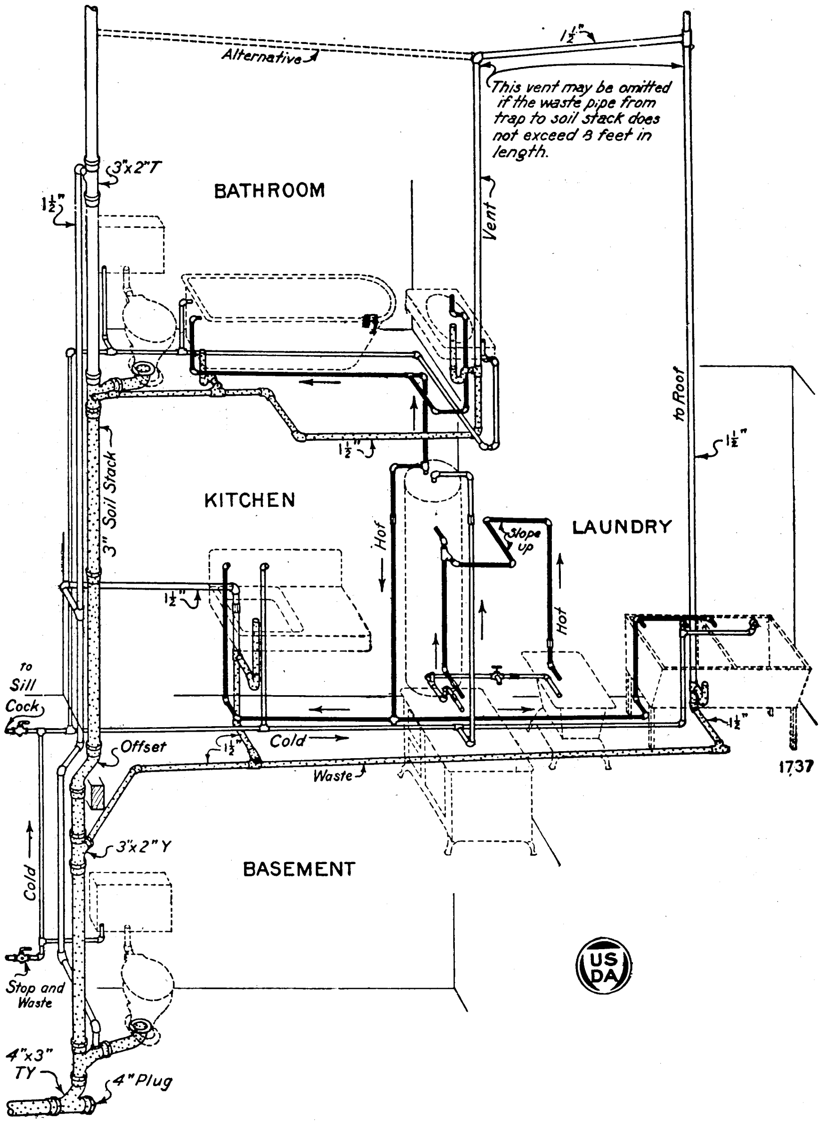

FIG. 28.—Roughing-in the drainage and water pipes for a two-story house with water-closet in the basement and laundry in a rear room. Drainage pipes are stippled, hot-water pipes are in black and cold water and vent pipes are outlined

boiler should be in proportion, both conforming to the hot-water requirements. A small water back and large boiler give insufficient hot water; a large water back and small boiler give overheated water with, perhaps, snapping, cracking, or rumbling noises.

Where an ordinary family uses hot water in small, frequent quantities a 30-gallon boiler is satisfactory; large, infrequent drafts require greater storage. Straight water backs for 30-gallon boilers vary from 13 by $4\frac{1}{2}$ by $1\frac{1}{2}$ inches to $13\frac{1}{2}$ by 7 by 2 inches, but on the average the heating surface is about $\frac{1}{2}$ square foot or $2\frac{1}{2}$ square

FIG. 29.—An enameled-iron apron sink with integral back and combination swing faucet. Every housewife should determine by experiment how high her sink should be set to give an easy, erect, working position; for a woman of average stature a favorable height to the top of the apron or rim is 36 inches (yard-stick high)

inches per gallon of boiler capacity. For a 40-gallon boiler the heating surface of the water back should approximate 100 square inches; for a 50-gallon boiler, 125 square inches. Under favorable conditions a good fire with a $\frac{1}{2}$ square foot water back and 30-gallon boiler will furnish 15 gallons of water per hour warmed from 60° F. to an average of 120° F.; under like conditions a fire for baking or roasting will furnish 20 gallons per hour. This is sufficient to give hourly 30 gallons of water tempered for bathing to approxi-

mately 100° F.; or to give all reasonable quantities of hotter water for dish washing and like uses.

Range boilers are made of copper or steel and in thicknesses or strengths to conform with the water pressure. If a boiler is supplied from an attic tank equipped with a ball cock, it may be light weight; for direct pressure it should be heavier. The tank system is less used now than the direct pressure because it requires more pipe and involves the objections to an upstairs tank in a dwelling. It does, however, have certain distinct merits, giving a steady, safe pressure on boiler and hot-water pipes and making it impossible to empty the boiler or water back by siphonage through the house service pipe. Another strong merit is the ready means of providing for expansion of the heated water and escape of air therefrom. This is done by running the hot-water pipe from the top of the boiler up and over the top edge of the tank.

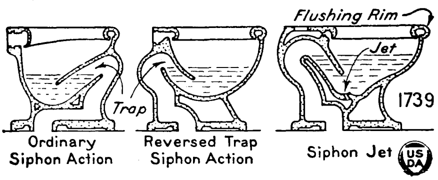

FIG. 30.—Sections of typical siphon action and siphon jet water-closets

Copper boilers are generally tin lined and steel boilers are galvanized inside and outside. The former are best because they impart no rust to the water, last longer, and look better.

The boilers are usually set vertically and close to the range. Sometimes they are concealed in a small wall closet adjacent to the chimney or placed in a bathroom not otherwise heated. A cellar location with heater above is undesirable because hot water does not readily circulate downward. A standard-weight, galvanized steel boiler 12 by 60 inches, 30 gallons capacity, costs about $12 and is suitable for 85 pounds working pressure; the same size in copper costs $25 to $45.

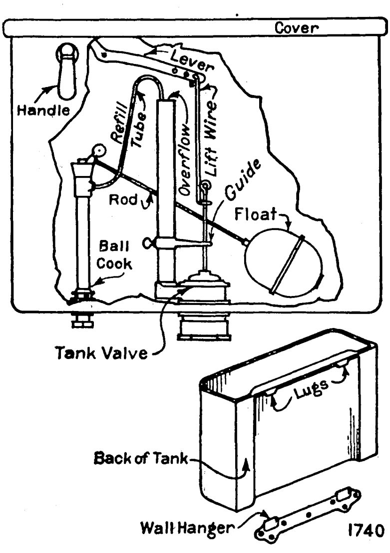

FIG. 31.—An enameled-iron flush tank with front wall cut away to show the essential working parts; below is shown the back of the tank with the lugs which engage the concealed wall hanger

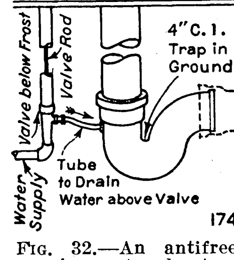

FIG. 32.—An antifreezing water-closet

Galvanized boilers usually have five 1-inch tappings, two in the top, one in the bottom, and two in the side. The pipes between the boiler and water back are generally ¾ inch, the connections being made with 1-inch bushings or boiler couplings. Copper boilers usually come with couplings inserted and with male thread for ¾-inch pipe. Figure 33 shows four ways of connecting range boilers and water backs; the advantages of each method are indicated in the notation. To prevent mixing the cold and hot water, the cold-water pipe is extended inside the boiler as shown. This inner pipe is generally ¾ inch, should have a ⅛-inch air hole tapped near its top to prevent siphonage, and should end at the level of the top of the water

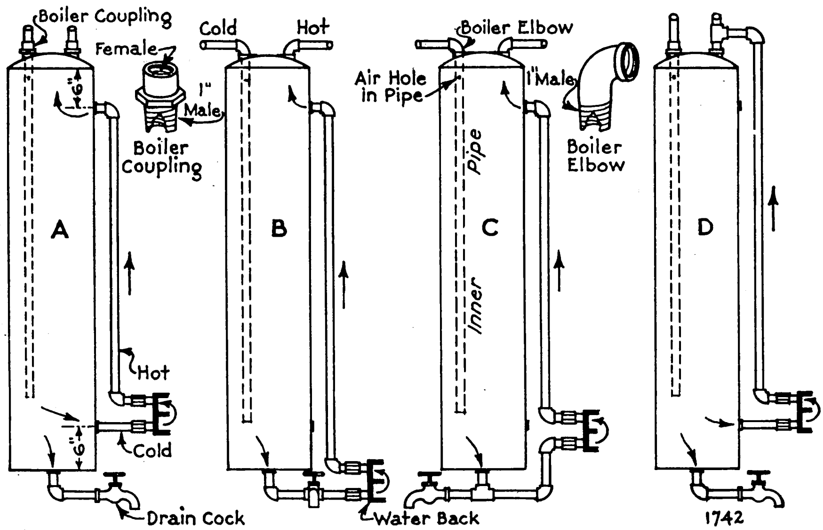

FIG. 33.—Four ways of connecting range boilers and water backs. The pipes are generally ¾ inch and preferably of brass. Arrows show the direction water moves. A, Standard tappings; short, direct connections; excellent for either water back or gas heater; gives several gallons of hot water in a short time; has ample space in which sediment may settle below the line of circulation; occasionally a pail of water should be drawn off at the drain cock. B, Cold-water flow pipe from bottom of boiler. C, A common method where the height of the boiler stand does not permit the straight connection shown in A and B. D, Connection just above the boiler; often used with a gas heater because small quantities of hot water can be drawn in a minute or two after lighting the gas; this connection is not as reliable as A, B, and C for the reason that if not properly made, cold water may short circuit through the heater and be drawn at hot-water faucets

back. It should be brass or copper pipe or heavy tubing, thus preventing rusting off or closure with rust; it is readily inserted in the boiler by means of a boiler coupling or boiler elbow having a 1-inch male thread and two ¾-inch female threads. Where the pressure is high, permitting small pipes, the two female threads may be ½ inch.

Figure 34 shows a simple, serviceable, homemade installation in a dairy wash room at Milo, Me. Figure 35 shows how the foregoing installation could be improved, utilizing either a wooden or steel barrel, force pump, and kitchen range. Figure 36 shows a boiler connected to a range and a laundry stove, thus making use of either or both sources of heat. Figure 37 shows a similar arrangement with a range, a gas heater, and a coil in the furnace.

To get warm water quickly where faucets are far from the boiler the hot-water line may loop back from the farthest fixture branch and be returned into the cold-water flow pipe from the bottom of the boiler to the water back (or furnace). Thus warm water constantly circulates through the boiler and past fixture branches. The system is suitable for large establishments, but the heat lost by radiation in a long circuit makes it uneconomical. If used, the circulation pipe and the boiler should have an insulating covering, and the return pipe should have a light swing check valve set 45° to the horizontal to prevent cold water moving from the bottom of the boiler through the return when a faucet is opened.

Caution: Serious range-boiler explosions have occurred because expansion of the hot water was cut off. This situation may result

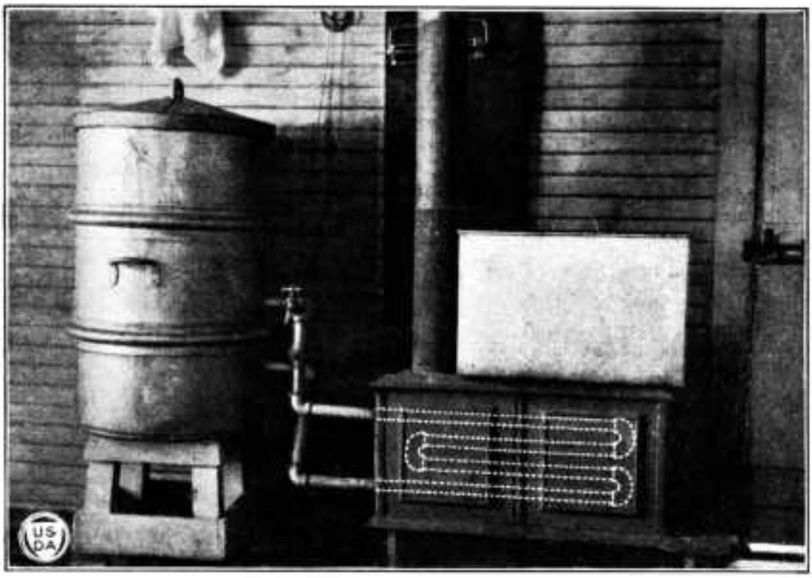

FIG. 34.—Homemade hot-water installation consisting of four lines of 1-inch black wrought pipe about 24 inches long joined by return bends and placed in a wood-burning stove and connected to a galvanized steel gasoline barrel 19 inches in diameter and 34 inches high; the barrel is supplied with cold water by pouring from a pail at the top; hot water is drawn at the faucet

from: (1) Frozen or scale-bound pipes; (2) thoughtlessly closing a valve on the cold-water line supplying a boiler under direct pressure; (3) use of a check valve or a pressure regulator on a direct-pressure cold-water supply; (4) nonoperation of a safety or a relief valve because of rusting and sticking.

The remedies are: (1) Lay the cold-water supply pipe below frost or otherwise protect it, and never allow the house temperature to fall much below freezing; if frozen pipes are suspected, open a faucet to see if the cold-water supply pipe is free; if not free do not start the range fire or gas heater until that pipe and all pipes from and to both the boiler and the source of heat have been thawed; the water back and connecting pipes should be cleared of lime deposit and rust whenever the circulation begins to get sluggish; the water back

should be removed and tapped with a hammer to loosen the lime or be filled with a solution of 1 part of muriatic acid and 7 parts of

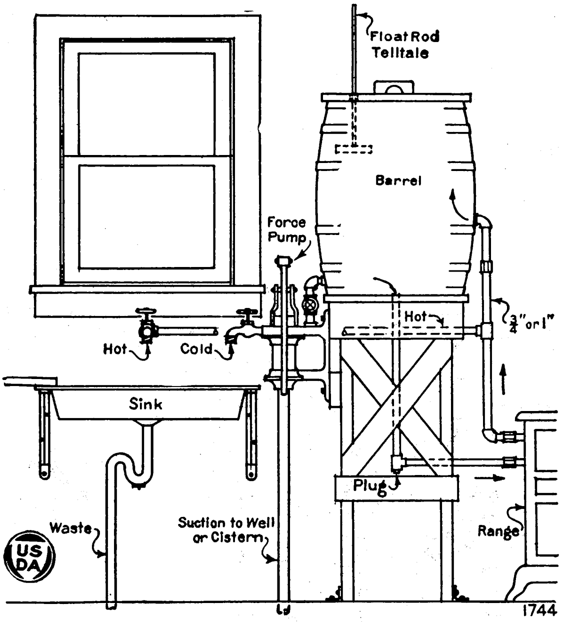

FIG. 35.—Homemade hot-water installation; as desired the pump forces cold water to the faucet or to the low side tapping in the barrel; hot water is drawn through the center side tapping and connecting pipe. By the use of a three-way valve or two single valves at the pump and suitable piping, the barrel or a tank could be placed above the kitchen, and thus supply cold water to a range boiler and hot and cold water to the sink faucets

water; after the lime is dissolved, the water back and connections should be well flushed with boiling water to remove the acid; (2) for convenience in making repairs, a valve is usually placed on the cold-water line between the range boiler and the source of supply; in a direct-pressure system this valve should never be closed when the gas heater or range fire is burning; (3) if a check valve is used on a metered service to prevent hot water backing up to the meter, the range boiler, if supplied by direct pressure, can be protected in two ways, (*a*) by attaching a safety or relief valve frequently examined to make sure that rust or sticking does not render it useless, (*b*) by placing a pipe or by-pass having a reversed check valve around the meter. A relief valve should always be installed if the system has a pressure regulator or pressure reducing valve.

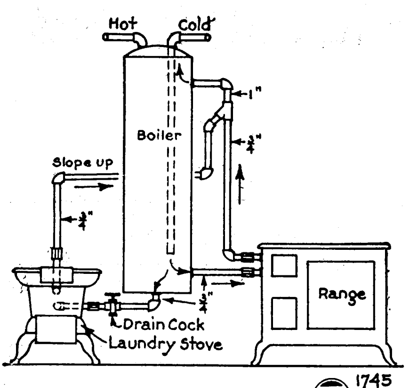

FIG. 36.—Boiler connected with a kitchen range and a laundry stove

Chattering in faucets and pipes and rumbling or knocking in range boilers are annoying; they show faulty but not necessarily dangerous conditions as many suppose. These troubles are generally due to vibration, slow, scale-bound, or air-bound circulation, or overheating. Faucets should be in thorough repair and pipes should be well secured and have clean bores. Circulation is often improved by using larger or better pitched pipes. One hot-water faucet should branch off from the highest point of a closed circuit, thus allowing air to escape every time that faucet is used. With a very hot fire, a range boiler may pound or knock and steam may sputter forth when a hot-water faucet is opened. Pounding may be due to the formation of steam in the water back and its sudden condensation as it enters the cooler water in the boiler; steam at a faucet indicates that the boiler supply is above boiling temperature.

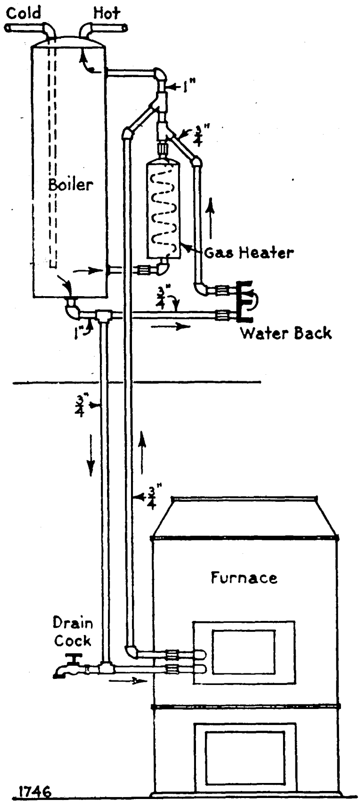

FIG. 37.—Boiler connected with a kitchen range, a gas heater, and a furnace

PROTECTION OF PIPES

All pipes should be safe from frost. Small water pipes freeze quicker than waste pipes and sewers which carry water more or less warmed. Latitude and local soil and cover conditions vary the depth to which frost goes into the ground. A fair guide for the laying depth of small water pipes is given in Table 6.

TABLE 6.—*Laying depth of small water pipes*

State	Depth	State	Depth	State	Depth
	Feet		*Feet*		*Feet*
Alabama	1½ to 2	Kentucky	2 to 3½	New Mexico	2 to 3
Arkansas	1½ to 3	Louisiana	1½ to 2	New York	4 to 6
California	2 to 4	Maine	4½ to 6	North Carolina	2 to 3
Colorado	3 to 5	Massachusetts	4 to 6	North Dakota	5 to 9
Connecticut	4 to 5	Michigan	4 to 7	Ohio	3½ to 5½
Florida	1 to 2	Minnesota	5 to 9	Pennsylvania	3½ to 5½
Georgia	1½ to 2	Mississippi	1½ to 2½	Tennessee	2 to 3
Idaho	4 to 6	Missouri	3 to 5	Texas	1½ to 3
Illinois	3½ to 6	Montana	5 to 7	Virginia	2 to 3½
Indiana	3½ to 5½	Nebraska	4 to 5½	Wisconsin	5 to 7
Iowa	5 to 6	New Hampshire	4 to 6	Wyoming	5 to 6
Kansas	2½ to 4½	New Jersey	3½ to 4½	District of Columbia	4

At spots liable to be caught by frost pipes may be boxed and surrounded with dry shavings, excelsior, sawdust, leaves, chopped

straw, charcoal, granulated cork, pea or nut size coke, or mineral wool.

Within buildings it is more convenient to use a commercial covering of wool felt or hair felt lined with tar paper. These coverings come in sizes to fit different pipes and fittings. They are in 3-foot lengths, split on one or both sides to slip over the pipe, and are fastened with wires or brass bands. Figure 38 shows two widely used kinds. The wool felt covering for ¾-inch pipe costs about 12 cents per foot. These coverings are sometimes used to deaden sound and to do away with condensation of moisture and drip from exposed overhead pipes. A good homemade covering is a tar-paper lining with a wrapping of felt, and the whole jacketed with canvas pasted or wired on and finished with a good waterproof paint. Old automobile tires cut in long narrow strips and wound spirally around the pipe are useful.

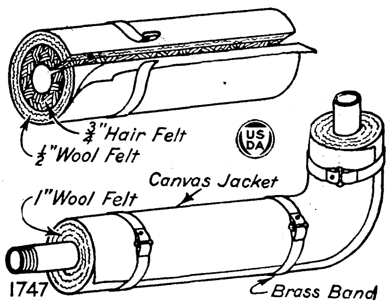

FIG. 38.—Two pipe coverings for protecting indoor water pipes from frost

The insulation of hot-water pipes and range boilers may be asbestos cement applied in plastic form or a commercial covering of

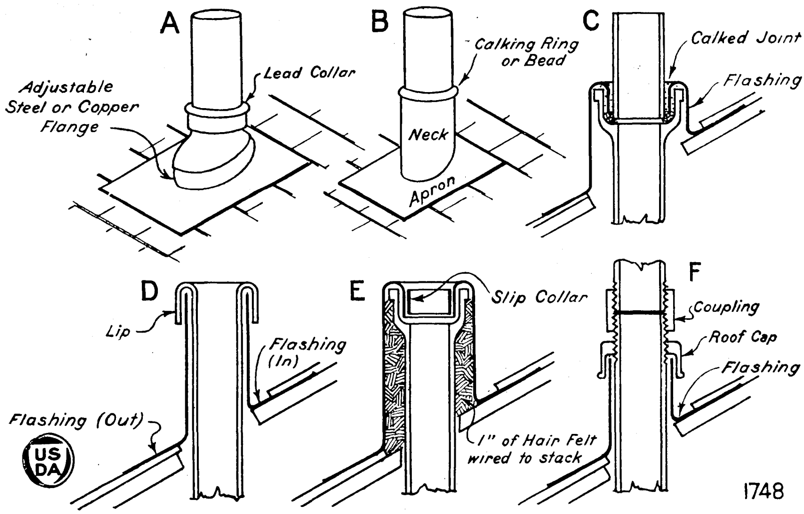

FIG. 39.—Six weather-tight roof connections. A, B, and D are simple commercial products adapted to pitched or flat roofs; B is a one-piece all-lead flange and D is a cast-iron pipe with extended lip covering the top of the flashing; C is ordinary cast-iron soil pipe with the flashing bent over and calked into the hub; E shows a good method of protecting a stack to prevent closure by frost; F shows a substantial screw-pipe roof connection

asbestos, magnesia, or plaster of Paris. Cork, hair felt, or wool felt lined with asbestos paper are very effective.

ROOF CONNECTIONS

Every pipe passing through a roof should have a lead, copper, or galvanized roofing flange. The apron of the flange is flashed into the roofing and the neck of the flange is made water-tight to the pipe 6 to 12 inches above the roof slope. The pipe is usually extended 12 to 18 inches above the roof, the shorter distance being preferable in very cold climates where the bore may be closed by frost. This trouble can be overcome by surrounding the pipe with 1 inch of hair felt or wool felt to completely fill the space between the neck of the flange and the pipe. Figure 39 shows six roof connections. Lead flanges are about 15 inches square and weigh 4 pounds per square foot (about $\frac{1}{16}$ inch thick). Copper and galvanized flashings weigh about 1 pound per square foot and approximate 1/50 inch in thickness. Figures 40 and 41 show how the lead collar is placed on the adjustable roof flange and beaten or calked against the pipe to make a water-tight joint.

FIG. 40.—Dropping the lead collar upon an adjustable roof flange

FLOOR DRAINS

Floor drains should not be installed unless there is actual need and frequent use, as in a creamery, cannery, slaughterhouse, pump room, or garage. A deep-seal trap as shown in Figure 42 is best.

CARE OF PLUMBING

Good, well-cared-for plumbing causes little trouble or expense. Frozen water pipes are a prolific source of trouble. Garbage, rags, newspapers, matches, and all other solids not readily soluble in water should never be thrown into water-closets or other fixtures; grease and fats should not be wasted through sink outlets. Solid substances clog traps and pipes;

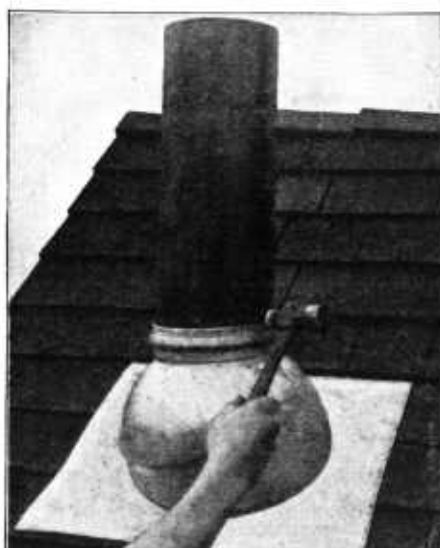

FIG. 41.—Beating down the lead collar to make a water-tight joint

greases adhere to the bore and gradually close it. Even the washstand trap may gather soap, grease, hair, and lint sufficient to stop it completely. After using a plumbing fixture, especially a kitchen sink, it is well to flush the trap and waste with clean hot water. Figure 43 shows simple tools for loosening and drawing out obstructions other than solidified grease. If a trap and the pipe leading from it have become solidly packed with grease, the trap should be disconnected at the slip and union joints and the grease should be dug out or be forced out with a stick. If a trap is not fully closed, the greasy matter may be burned out with a strong caustic solvent, of which numerous brands are on the market. The best costs respectively 50 cents in 1-pound and 80 cents in 2-pound cans, and the maker's directions for safely using are printed on the container. Caustic potash (lye) and caustic soda are widely used. Caustic soda is less effective than caustic potash because it unites with grease to form hard soap whereas potash forms soft soap. Caustic soda costs less—about 12 cents per pound in 10-pound pails—and constitutes most of the ordinary commercial lyes.

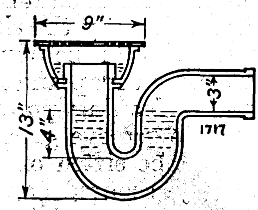

FIG. 42.—A typical floor drain and trap with 4-inch water seal

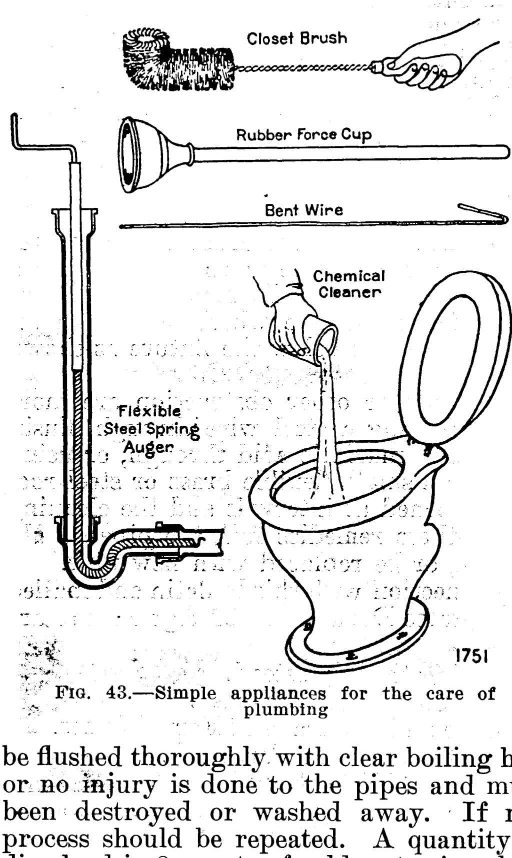

FIG. 43.—Simple appliances for the care of plumbing

Chemicals of the character described generate much heat, making them useful to thaw frozen pipes. Large quantities should not be used in or about plumbing because of the expense and the possible injury to pipes and fixtures. The chemical should be kept where children can not get it. The best use of drain-pipe solvents is as an occasional aid in keeping traps and pipes free and clean. Several times a year, or whenever the waste water begins to run away slowly, the pipe should be well flushed with boiling hot water to soften the grease. This should be followed with a strong solution of the chemical, and a half hour later the pipe should be flushed thoroughly with clear boiling hot water. In this way little or no injury is done to the pipes and much of the grease will have been destroyed or washed away. If not successful at first, the process should be repeated. A quantity of the chemical should be dissolved in 2 quarts of cold water in a large pail, the solution being

well stirred and poured through a funnel directly into the pipe. The face, hands, clothing, or an open flame (in confined space) should not come in contact with the chemical or its fumes.

All fixtures should be cleaned daily. No sharp or pointed utensil, sandpaper, coarse, gritty powder, scouring soap, oil, acid, or acid preparation should be used because they tend to injure the thin shiny glaze, literally the skin of enameled and vitreous wares. The treatment should be much the same as with table crockery, relying mainly on soap and hot water. As needed a very fine specially prepared cleaning powder costing 25 cents for 1-pound cans may be used to remove grime and stains. A small quantity of the powder should be sifted on a damp cloth and the fixture be wiped out or lightly scoured, and rinsed with clean, warm water. A little kerosene on a cloth is sometimes used to remove paint and grease. Soap, water, and a brush are sufficient ordinarily for cleaning water-closets. If a vitreous bowl has become badly incrusted, discolored, and foul smelling, a small quantity of chemical closet cleaner may be sifted into the water in the trap, be allowed to stand several hours and then be flushed away. Figure 43 shows the method of applying the cleaner, which reaches and thoroughly cleans the inaccessible parts of the trap.

Faucets should never be jammed. If they drip after moderate pressure on the handle, it is because they need new washers. Washers are small round disks about ⅛ inch thick; those of asbestos and rubber or fiber composition have largely replaced leather and are suitable for both hot and cold faucets. They cost little and are easy to put in after the water has been shut off. The operation is as follows: With a monkey wrench unscrew the cap nut over the stem packing at the top of the body of the faucet; take hold of the handle and turn it to the left to unscrew and to remove the stem from the body; with a small screw driver unscrew the washer screw at the bottom of the stem; replace the worn washer with a new one and replace the stem and cap nut. In making repairs of this kind it is a great convenience to have wheel handle valves installed on the fixture supply pipes just below the fixture as shown in Figure 22.

Small water pipes closed by rust or other obstruction are more or less successfully opened by pushing a steel wire through, flushing with a powerful pump, forcing muriatic acid through, or using a swab or wire brush attached to a small, flexible brass or steel rod. In long lines, the pipe may be opened at intervals and the cleaning be done section by section. If these remedies fail, the pipe should be taken up, cleaned, and relaid, or be replaced with new pipe.

Publications of interest in connection with this bulletin and mailed free on request by the United States Department of Agriculture are as follows:

Farmers' Bulletin 1132, Planning the Farmstead.
Farmers' Bulletin 1180, House Cleaning Made Easy.
Farmers' Bulletin 1227, Sewage and Sewerage of Farm Homes.
Farmers' Bulletin 1279, Plain Concrete for Farm Use.
Farmers' Bulletin 1448, Farmstead Water Supply.
Farmers' Bulletin 1460, Simple Plumbing Repairs in the Home.
Farmers' Bulletin 1572, Making Cellars Dry.

U. S. GOVERNMENT PRINTING OFFICE: 1930